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CANEWS II OPERATOR INTERFACE: PRELIMINARY DESIGN (U)

by

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ABSTRACT

CANEWS II receives emitted radar pulses, groups related pulses, classifies pulse parameters and matches the classifications against an emitter library in order to make identifications. The operator interface presents pulse, emitter and platform information to the operator, and allows the operator to view and manipulate the data in a variety of ways. In this paper, the preliminary design for the CANEWS II operator interface is described in detail, along with plans for subsequent modifications.

RÉSUMÉ

CANEWS II intercepte les impulsions radar, regroupe celles qui s'apparentent, extrait leurs paramètres et les compare au contenu d'une librairie d'émetteur à des fins d'identification. L'interface à l'usager présente l'information sur les impulsions, les émetteurs et les plate-formes à l'usager, et permet à celui-ci de visualiser et de manipuler les données de plusieurs façons. Dans ce document, la conception préliminaire de l'interface à l'usager de CANEWS II est présentée en détail, avec des suggestions pour son amélioration ultérieure.

EXECUTIVE SUMMARY

DREO has long been concerned with assisting Naval ESM operators to analyze their radar environment. CANEWS II processes parametric information from radar emitted pulses. The pulses are grouped then classified using parameters such as frequency, pulse width and time of arrival. The grouped and classified pulses are then matched against an emitter library to make identifications. Pulse and emitter information will be available to the ESM operator, along with own ship information, platform information and intelligence information.

In this paper, the preliminary design for the CANEWS II operator interface is presented. The overview of the display format and functionality is presented, along with descriptions of the actual layouts and functions.

Modern display technology is used in the operator interface. This includes multiple windows, buttons and pull-down menus.

The display layout has been designed to be very flexible to allow the operator to tailor the interface to his immediate requirements. This flexibility would be required due to the vast amount of information available to the operator and the variety of functions the operator may have to perform.

Colour is used to assist the operator but is not used excessively. Minimal, effective use of colour is intended to prevent confusion.

The contents and functionality of each window available to the operator is described. In addition, the functionality and operation of each button and menu item within each window is described. The windows include: the Fixed window, the Active Tracks Tabular window, the Active Track Situation Display window, the Track Description window, the Change View window, the Track Analysis window, the Pulse Stream Browser window, the PRI Histogram window, the Falling Raster window, the Active Platforms Tabular window, the Active Platform Situation Display window, the Platform Description window, and the Platform Analysis window.

Plans for additions and improvements to the operator interface design are described throughout the paper. These plans will be implemented in future iterations of the interface.

The preliminary design of the CANEWS II operator interface has been received favourably by ESM scientists and operators. It is hoped that discussion and suggestions will come from the ESM community and that the final operator interface will be optimal.

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1.0 INTRODUCTION

DREO has long been concerned with assisting Naval ESM operators to analyze their radar environment. In what can often be a dense environment the operator must be aware of all emitting radars, know their identity if possible but at least if they are hostile or friendly, and know from what direction they are emitting.

Radars emit pulses which contain information that can be processed to classify an emitter and, hopefully, identify the emitter by a library match. This pulse information includes the frequency, pulse width, bearing, and the time of arrival parameters. The processing involves grouping what appear to be related pulses, classifying the parameters within the group, and matching the classification against a library of emitters to make an identification.

Originally the radar ESM system known as CANEWS was developed at DREO and then installed on Royal Canadian Navy ships. Sea trials allowed evaluation of the system, and numerous improvements were incorporated in the subsequent ESM system. This subsequent ESM processing system was called the Advanced Modular ESM Processor (AMEP). AMEP together with updated receivers comprises CANEWS II, which is currently at the Advanced Development Model stage.

The original CANEWS operator interface included a colour display of the ESM situation graph, the parametric data, and library information. The information intensive display was made as legible and straightforward as possible to avoid confusing the operator. Operator feedback about their likes and dislikes of the original CANEWS have been considered for the development of the CANEWS II operator interface.

The purpose of the CANEWS II operator interface is to allow the operator to view the entire ESM environment at all levels of interest. This includes pulse level, emitter level and platform level. In addition, the operator interface will enable the operator to input his deductions back into the system. There is considerably more information and functionality available in the CANEWS II operator interface than in the original CANEWS interface.

In this paper, the overview of the display format and functionality is presented. In addition, the current layout and the thoughts for future changes to the operator interface are described. This paper, purposely written before the operator interface design is finalized, is intended to present the layout, but more important, stimulate thought and discussion from the planners, researchers, developers and operators in the ESM community.

The current mock-up of the operator interface runs on an ALR Power Cache 33/4e 486 processor with a Pepper Pro 1280 graphics board controlling a Mitsubishi monitor. Input to the operator interface is by mouse and keyboard. The software for the operator interface is written in Digitalk Smalltalk/V286, using Acumen Software Widgets/V286 for its user interface toolkit and OTI ENVY/Developer for its software development management tools.

2.0 OPERATOR INTERFACE OVERVIEW

It is intended that the operator interface present pulse, emitter, and platform information to the operator as required and as available. It is also intended that the operator have the capability to enter his deductions about the ESM situation into the system to augment the information being processed.

Modern display technology is used in the format and functionality of the operator interface. This includes: multiple windows that can be opened or closed, overlapped or tiled, sized and moved; buttons for fast action; pull-down menus for easy accessibility of extensive functionality; and, ultimately, concurrent updates in multiple windows.

There is a vast amount of information available for the operator to access. All the information available to the operator cannot fit on the display at the same time. It is intended that the operator be able to view what information he believes to be relevant at a given time, in the format most suitable to him at that time. In order to achieve this, the display will be fully flexible and the display contents able to be fully tailored by the operator. This flexibility includes sizing, positioning and the information content of windows.

The information to be displayed has varying degrees of importance. Critical information, such as active threats, will be displayed in non-removable or fixed windows. Other less critical information may be displayed when required, in windows that could be partially obscured or sized according to importance.

The operator interface will use one 20 inch monitor. For the original CANEWS a two monitor operator interface was tested. This approach failed as it was found that the operators could only concentrate on one screen at a time and, as a result, ignored the second screen.

With current display technology a very large number of colours are available for display. However for the purposes of an ESM operator interface no more than eight colours should be used [1]. Use of more colours leads to confusion over their meaning. Certain colours would have specific meaning to the operator. For example, red indicates threat, orange indicates hostile, green is for neutral, and cyan is friendly. Backgrounds and general information should be in neutral, non-intrusive colours.

The development of the layout of the CANEWS II operator interface is being done in conjunction with ESM operators. Comments resulting from the original fielded CANEWS systems were considered when developing the CANEWS II operator interface. In

addition, ESM operators have been invited to review the progress of the CANEWS II operator interface development so that their ideas and suggestions can be immediately incorporated. In this way it is hoped the ESM operators who will ultimately use the system will be happy with the end result.

3.0 PRELIMINARY DESIGN DISPLAY CONTENT

Each window and the functionality within each window is described in this section. Operation and functionality for each button and each menu within each of the windows is also described.

The fixed window is a special case. It remains in a fixed position at the top of the screen. The operator cannot close it, move it, or change its shape. It is intended that the operator will not be able to obscure the information in this window since it contains critical information, including potential threats which must always be visible to the operator.

All other windows are entirely under the operator's control. Any number of windows can be open at once. All but the fixed window can be closed or made to disappear (see Appendix A for method). All but the fixed window can be moved (see Appendix for method). In some of the panes of some of the windows there may be text or data that can be scrolled or shifted (see Appendix A for method). The scroll and shift bars indicate what area in the data is being viewed. In future, all but the fixed window will be able to be re-sized. Several of the windows can be re-sized in the current version (see Appendix A for method).

3.1 FIXED WINDOW

This window is shown in Figure 1.

This window cannot be closed, moved, or obscured during operation since it includes information of significant importance. Some of this information, such as own ship heading, is constantly referred to; some information, such as error messages, periodically informs the operator; and some information, such as immediate threat warnings, is critical.

Within the fixed window there is a "status" area which indicates "OK" if CANEWS II is operating as expected without system faults. There is a "time" area which indicates the local and GMT times and the date. In future the format of the data and time will be the full date (D/M/Y) and time in GMT, as requested by ESM operators [2]. There is a "messages" area which lists system faults and operator faults. The operator can scroll through the pane of messages. In future the operator may be able to delete messages he has reviewed.

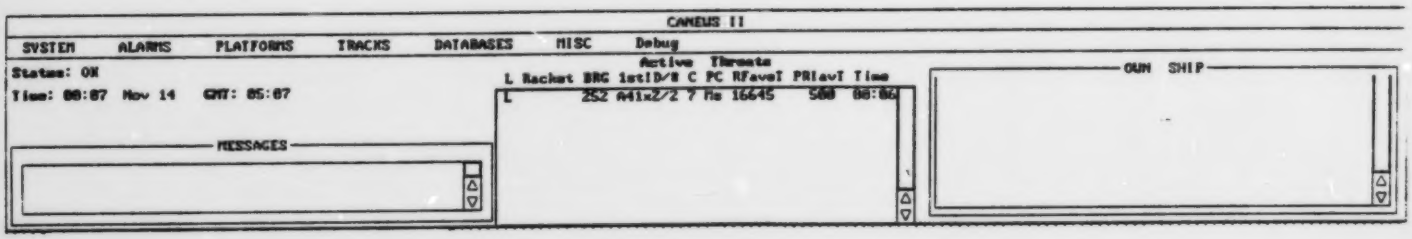

Figure 1 The Fixed Window

Also within the fixed window there is an "Active threats" area. When an emitter that has been identified as a threat appears in the environment, the information available on it appears in this area, or pane. The information includes:

L - locked on (blank if not locked on)

Racket - alphanumberic racket number (assigned by the command and control system)

BRG - bearing of received emissions (three digits with leading zeros if necessary)

1stID - the elint notation of the first candidate on the list of possible library match identifications

- number of candidates identified as possible emitter library matches (of varying confidence)

C - confidence in the reliability of the library identification of 1stID

PC - platform class (eg. air, surface, missile)

RFaveT - average frequency followed by frequency type

PRIavT - average PRI followed by PRI type

Time - earliest time this emitter was received (indicated in HH:MM, hours and minutes)

ESM operators have indicated that they would like the capability to alter racket numbers in order to allow informative labelling. [2]

ESM operators have indicated that in future they would want the common emitter identification or nickname also included. In addition, PRF values are preferred to PRI values by ESM operators. It has also been requested that Time be GMT. [2]

Currently when information is added to the threat pane a buzzer sounds in order to alert the operator. In future the text in the window will be displayed in red to give it more prominence.

The "own ship" pane of the fixed window will include information such as own ship's heading and speed, latitude and longitude, and a list of other ships in own force.

In future, after trial use, the size and layout of the fixed window will be optimized.

3.1.1 MENUS

All of the menu titles are listed. The menu titles appear below the title bar of the window. For each menu title there is a list of menu items that can be accessed (see Appendix A for method). The functions for each of the menu items are described.

System:

Bite: This is the "built in test" or system start-up test. In future it will be operational.

Halt: This freezes emitter inputs for software test purposes. This function will not be available or needed in the operational operator interface.

Shutdown: Stop CANEWS II.

Alarms:

Alarms on: This makes all visual and auditory alarms functional.

Visual only: This makes only the visual alarms functional.

Alarms off: This turns off all visual and auditory cues.

Platforms:

Platform PPI: This opens the platform situation display. If there is sufficient space in the menu, this may in future be called "Platform Situation Display".

Platform Table: This opens the platform tabular display window.

Both: This opens the platform situation display and the tabular display. These windows are linked in that the subset of emitters appearing in one appears in the other. It could happen that a situation display is adjacent to a tabular display that is not linked to it. This could be confusing to the operator who would expect to see related events occurring in the adjacent windows. To alleviate this confusion it is planned to have a numbering scheme to indicate to the operator which windows are linked. Of course the operator can always simplify the screen content by closing superfluous windows.

Tracks: References to "tracks" may be changed to "emitters"

since that term is more familiar to the operator.

Track PPI: This opens the track or emitters situation display window. If there is sufficient display space, this may in future be called "Emitters Situation Display".

Track Table: This opens the track tabular display window.

Both: This opens the track tabular and situation display windows. As described for platform tabular and situation windows, the data in these two windows are linked together.

Databases: Currently these are non-functional and do not access the indicated databases. It is expected that the databases will be structured hierarchically and the operator will be able to make queries of the database of choice.

Emitter DB: This will access the database of the library of emitters.

Platform DB: This will access the database of all the platform information.

OB DB: This will access the order of battle database.

Hultec DB: This will access the Hultec, or precision PRI, database.

INT DB: This will access the intelligence database.

Misc:

Pending Tasks: In the future, this will allow the operator to access the list of tasks or analysis problems that the system could not resolve. These problems can be tackled by the operator when time is available. An example of one of these tasks could involve an unresolvable ambiguity in an emitter identification. [3]

Log: This accesses the stored activity log. This includes the arrival times and movements of the various emitters.

Elint Log: This accesses additional elint information collected on particular emitter types.

Debug: These are development tools for checking on formats and allowing tests. The debug menu and its functions will not be available or needed in the operational operator interface.

allows the window layout information to be examined.

Advance Game: This steps through a stored set of data in order to allow testing of the various windows at consistent steps.

3.2 ACTIVE TRACKS TABULAR WINDOW

This window is shown in Figure 2.

The data on received emitter pulses is listed in tabular format with the following data available: L, Racket, BRG, 1stID, #, C, PC, RFaveT, PRIavT, Time. The descriptions of each of the above is the same as that given for the Active Threats pane described in Section 3.1. Emitters of interest can be selected, or clicked on (see Appendix A for the method), and the line of data associated with that emitter will be highlighted in reverse video.

3.2.1 BUTTONS

Sort by: By clicking on the button to the right of "Sort by" a list of possible sort parameters is shown including: Track ID, Bearing, RF, and PRI. Currently "Sort by" is not operational but in the future by choosing one of these button menu items the tabular list will be sorted on the chosen key. It is intended that "earliest time seen" will be added to the list of possible sort keys.

Describe Selection: If an emitter has been selected then this button opens the detailed emitter (or track) description window (described in Section 3.4). If no emitter has been selected then a message about this oversight appears in the "Messages" pane of the Fixed window (described in Section 3.1). In future, in order to better inform the operator, and to prevent time being wasted, the button text will appear "greyed" or at half intensity when it is inactive (no emitter selected).

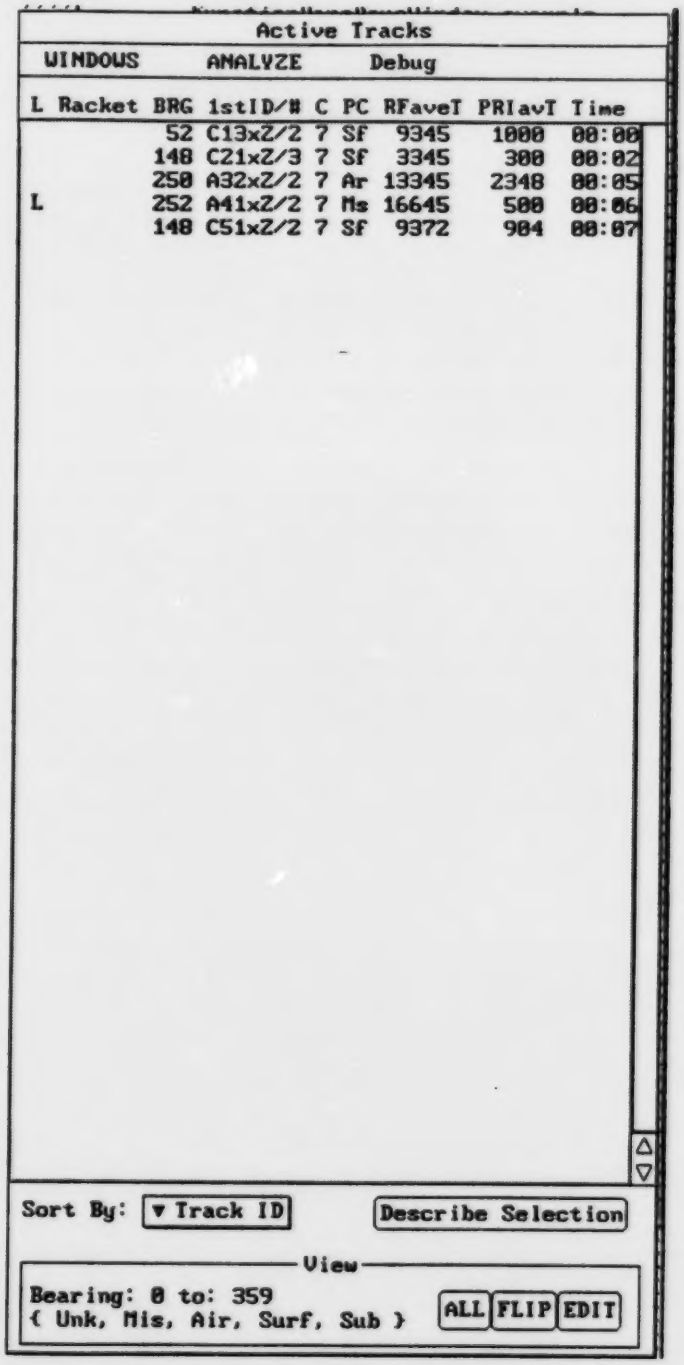

Figure 2 The Active Tracks Tabular Window

View: This area includes a "view" description which includes the bearing range of the sector in which the operator is interested, and the types of platforms of interest to the operator. The view's EDIT button opens a Change View window (described in Section 3.5). The view's FLIP button makes the complement of the current sector the new sector and makes the existing set of platform types become the complement of that set. For example, if the current sector is from 0 to 90 degrees and the platform types set is (Unk, , Air, , Sub), then the FLIP would cause the current sector to be from 90 to 0 degrees and the platform types set to be (, Mis, , Surf,). In the future this button will only cause a FLIP of the bearing range since flipping the types of platforms as well is too confusing. The ALL button allows the operator to quickly see all emitters on all bearings once again.

3.2.2 MENUS

Windows:

Track Plot: This opens the situation display window that corresponds to this window if it is not already open. If the corresponding situation display window is open it simply becomes the active window.

Group Windows: This aligns related tabular, situation and detailed description windows by positioning them beside each other in their original locations.

Clone Window: This creates a duplicate copy of the window. This new window will not be linked to data in the window from which it was cloned. For example one window could be viewing the sector 0 to 90 degrees and the other window could be viewing the sector 0 to 360 degrees and only missiles. The situation display windows will only display the data related to the tabular windows with which they are linked.

Close View: This closes the linked tabular window, situation display window and descriptions windows that are open.

Analyze:

Analyze Track: This opens a Track Analysis window (described in Section 3.6).

Debug:

Inspect Window: This opens a Smalltalk browser which allows the window layout information to be examined.

3.3 ACTIVE TRACK SITUATION DISPLAY WINDOW

Examples of this window are shown in Figures 3a through 3d.

The data on received emitter pulses is presented in one of a number of graphical displays (listed below). The default display format is RF vs BRG (Polar). Each emitter is represented by a symbol in a representative colour: red - threat, orange - hostile, green - neutral, cyan - friendly. In the current displays the symbols are rectangles but in the future the symbols will be standard NTDS symbols. In the future an own ship symbol will be in the centre of the polar plots.

An emitter of interest can be selected by being clicked on, or by being boxed, (see Appendix A for the methods). In order for further analysis to be done on a specific emitter it must first be selected, or highlighted.

In future the situation displays will indicate the sector of interest to the operator by using lines or highlights at the appropriate bearings.

The choice of situation display formats includes:

a) RF vs BRG (Polar):
This format is shown in Figure 3a. It is a polar display with RF (0 to 20 GHz, 0 GHz at the origin) along the axes and 0 to 360 degrees around the polar circle.

b) AMP vs BRG (Polar):
This format is shown in Figure 3b. It is a polar display with amplitude (0 to 60 dB, 60 dB at the origin) along the axes and 0 to 360 degrees around the polar circle.

c) RF vs BRG (XY):
This format is shown in Figure 3c. It is a cartesian display with bearing along the x axis, and RF (0 to 20 GHz) along the y axis.

d) AMP vs BRG (XY):
This format is shown in Figure 3d. It is a cartesian display with bearing along the x axis, and amplitude (0 to 60 dB) along the y axis.

3.3.1 BUTTONS

Plot: By clicking on the button to the right of "Plot" a list of possible plot formats is shown including: RF vs BRG (Polar), AMP vs BRG (Polar), RF vs BRG (XY), AMP vs BRG (XY).

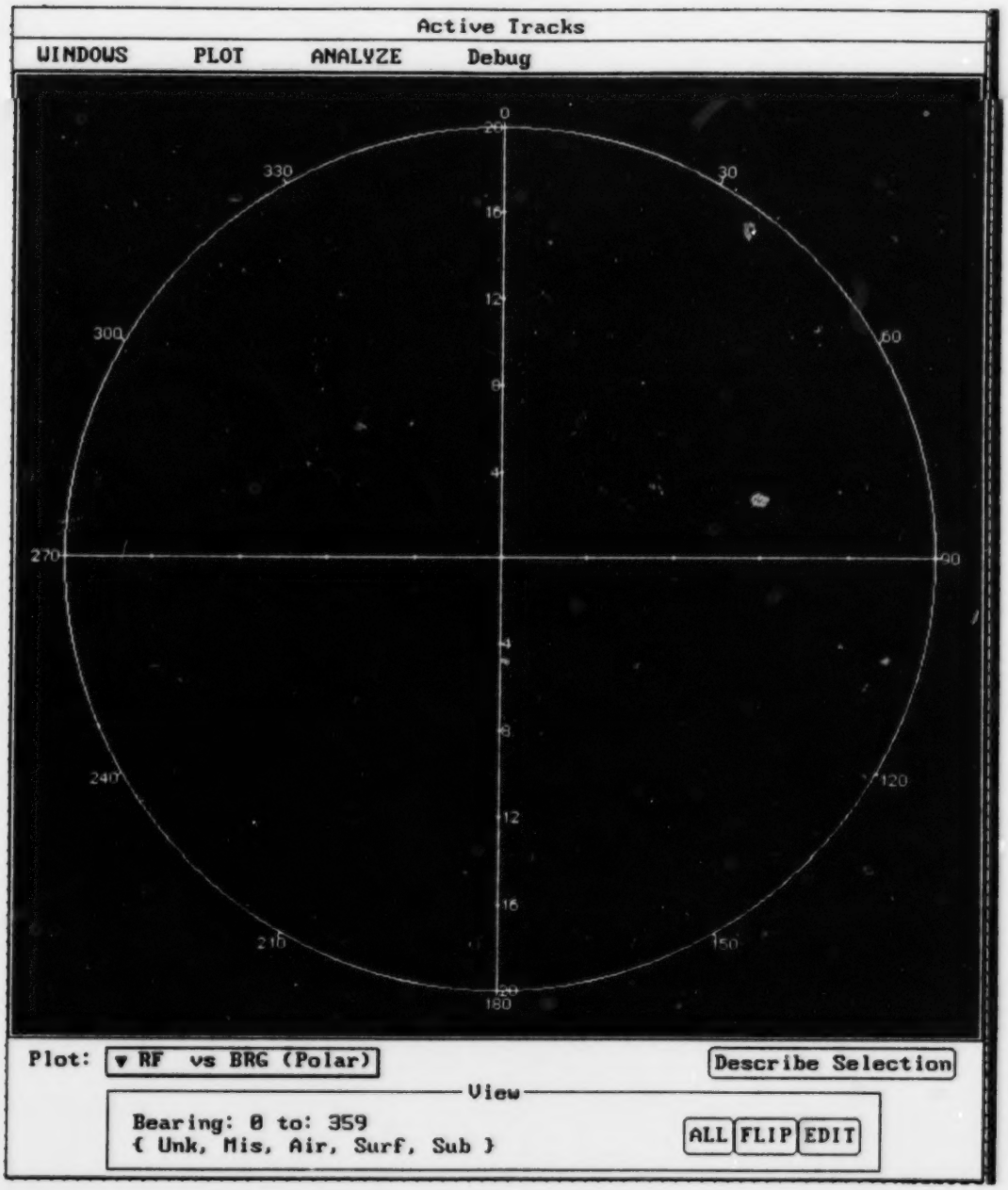

Figure 3a The Active Tracks Situation Display Window (RF vs BRG (Polar))

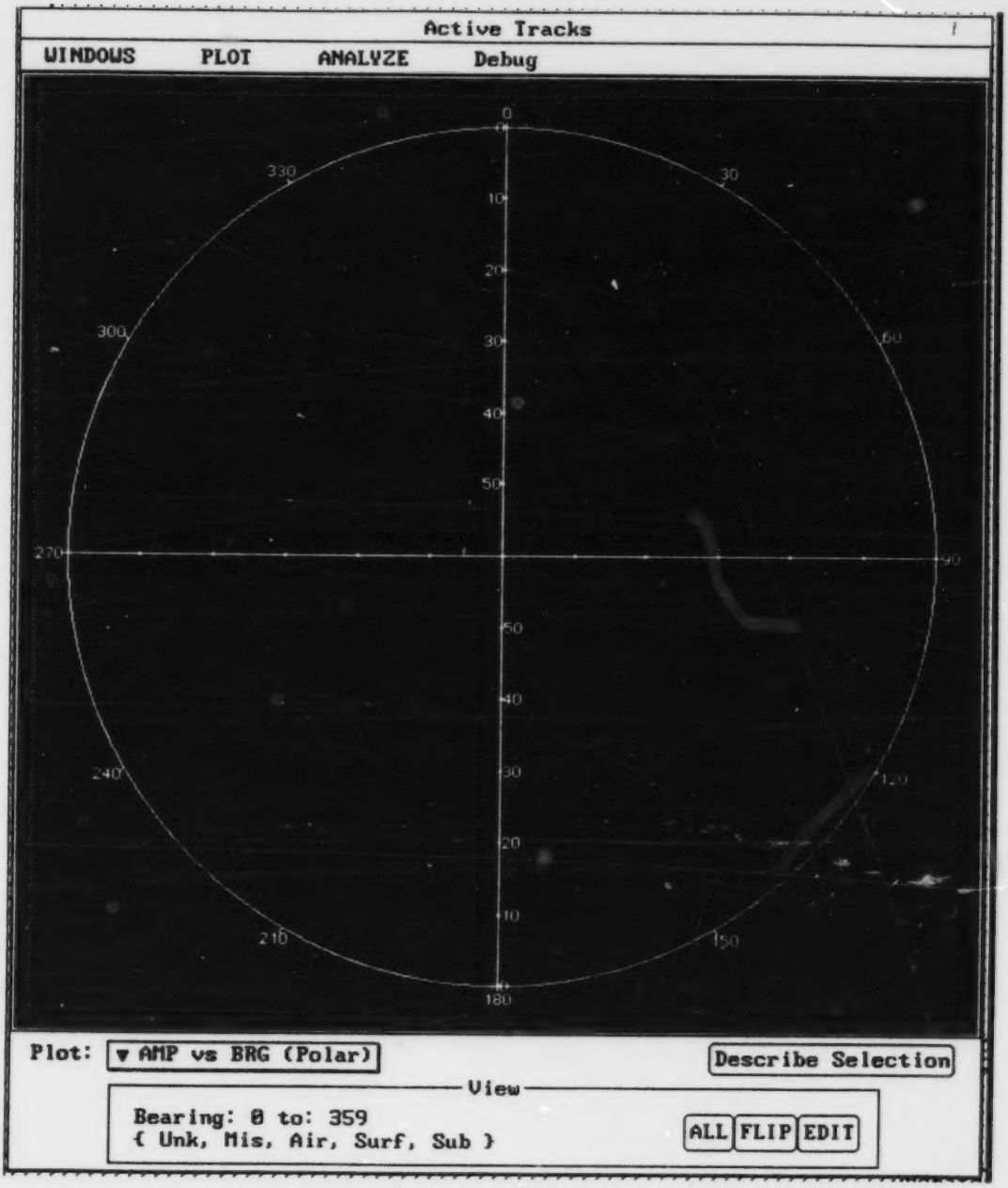

Figure 3b The Active Tracks Situation Display Window (AMP vs BRG (Polar))

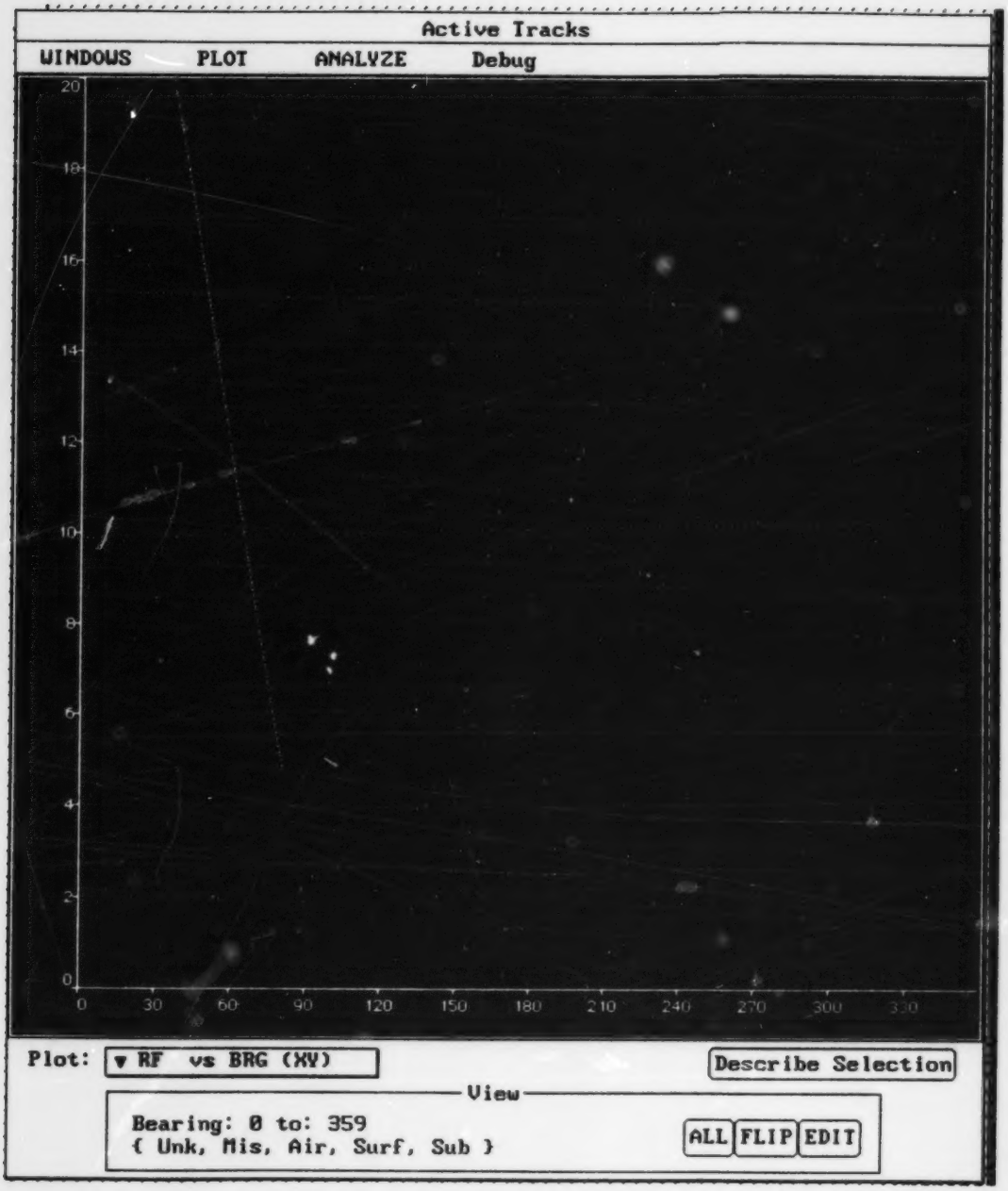

Figure 3c The Active Tracks Situation Display Window (RF vs BRG (XY))

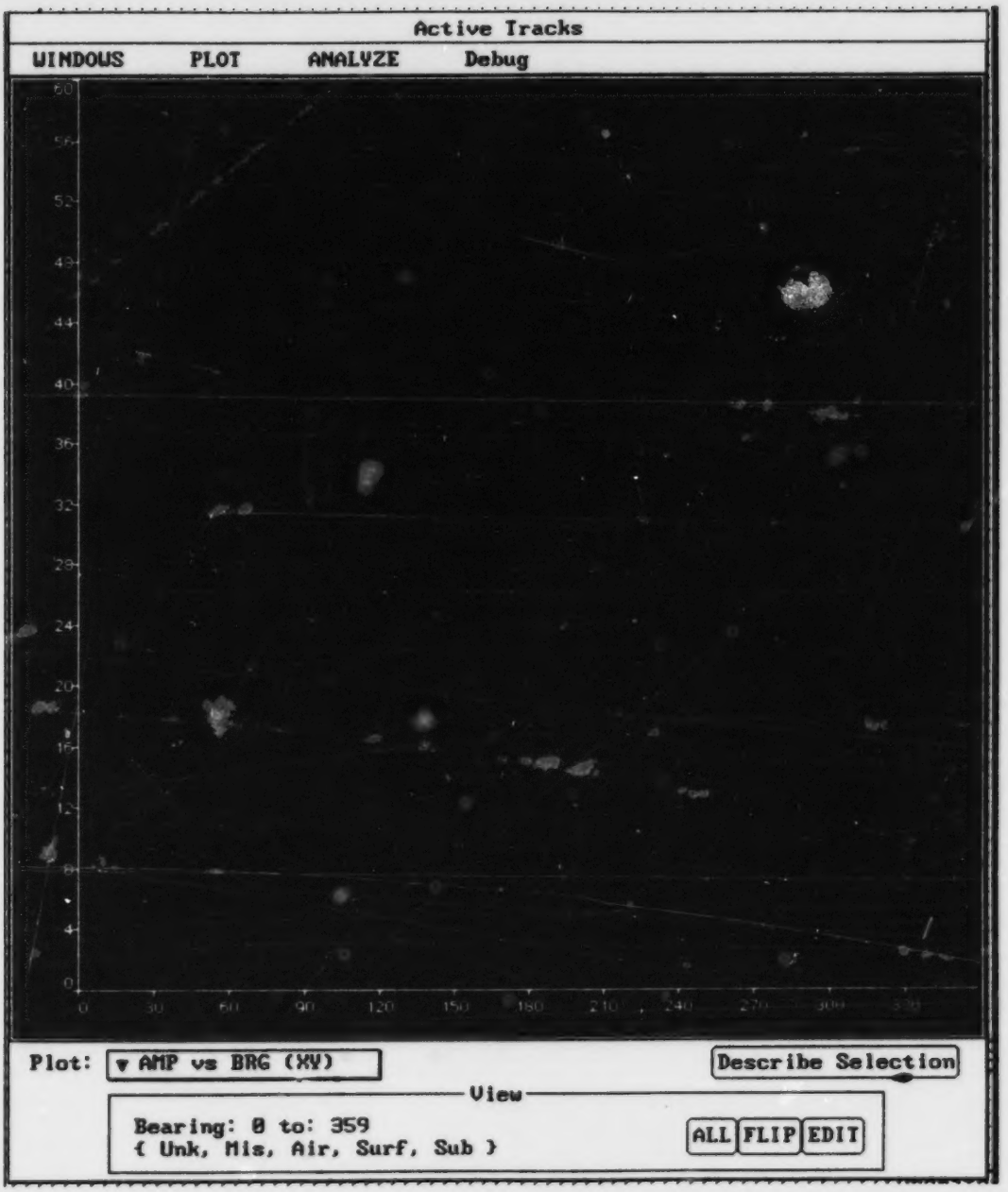

Figure 3d The Active Tracks Situation Display Window (AMP vs BRG (XY))

After choosing one of the button menu items the graphical plot will be drawn in the chosen format.

Describe Selection: As described in Section 3.2.1.

View: As described in Section 3.2.1.

3.3.2 MENUS

Windows:

Track Table: This opens the corresponding tabular display if one is not already open. If the corresponding tabular display is open it becomes the active window.

Group Windows: As described in Section 3.2.2.

Clone Window: As described in Section 3.2.2.

Close View: As described in Section 3.2.2.

Plot:

Toggle Grid: This draws the grid over the graph if it not already overlaid, and removes the grid if it was already there.

Zoom: This causes a zoom to allow the operator to view an area of the graph in detail. Currently the operator can partially zoom on the cartesian displays by using the Change View window (described in Section 3.5) since a narrower choice of bearing causes the cartesian to rescale the bearing axis. In future it will be possible to zoom on polar and cartesian display using the zoom menu item. The area of interest for the zoom will be indicated by a rectangle delineated using the mouse.

Analyze:

Analyze Track: As described in Section 3.2.2.

Debug:

Inspect Window: As described in Section 3.2.2.

3.4 TRACK DESCRIPTION WINDOW

This window is shown in Figure 4.

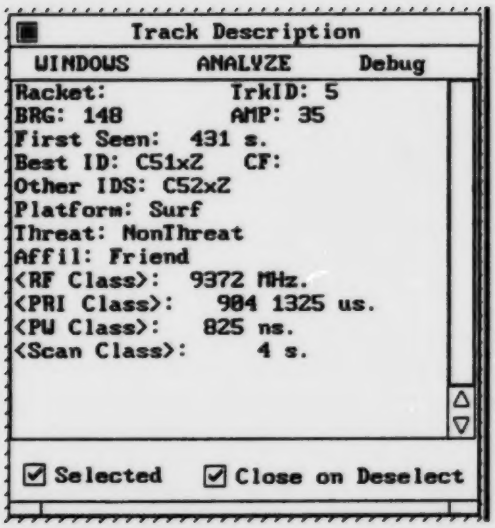

Figure 4 The Track Description Window

In this window the expanded data information on the selected emitter is displayed. The information includes:

Racket - the operator indicated racket number (also in tabular window)

TrkID - the system track number

BRG - the bearing of the received emissions (also in tabular window)

AMP - the signal strength indication

First Seen - earliest time this emitter was received (indicated in seconds elapsed since midnight)

Best ID - the elnot for the best emitter match in the library

CF - confidence in the reliability of the library identification (also in tabular window under C)

Other ID's - the other possible emitter matches from the library; each has lower confidence than the Best ID

Platform - the type of platform this emitter is on (eg. surface)

Threat - the threat status; this has to do with the type of platform; the threat types include: unknown, immediate threat, threat, threat associated, and non-threat [3]

Affil - the list of affiliations; this has to do with countries that own the emitter; the affiliation types include: unknown, hostile, neutral, friend [3]

<RF Class> - the information about the RF classification such as the RF type and range[s] of RF values

<PRI Class> - the information about the PRI classification such as the PRI type and range[s] of PRI values

<PW Class> - the information about the PW classification such as the range of PW values

<Scan Class> - the information about the Scan classification such as the Scan type and the Scan values

ESM operators requested that First Seen be GMT, and that the list of Other ID's be limited to three to avoid confusion [2]. It is intended that GMT will be used. However, the entire list of other emitter matches may be required since any one of them could in fact be the true match. Perhaps, if this window becomes too confusing with a long list of Other ID's, then the list could be accessed in a special window.

3.4.1 BUTTONS

Selected: If this button contains a check mark then the contents of the window apply to the currently selected emitter. If the button is clicked on, the emitter becomes unselected in the active tracks tabular and situation windows, and the track description window closes if the "Close on Deselect" is check marked.

Close on Deselect: If this button contains a check mark then the window will remain open only while the current emitter is selected. If this button does not contain a check mark then this window will remain open until the operator specifically closes the window. Having more than one detailed description window open at a time allows the operator to compare various emitters.

3.4.2 MENUS

Windows:

Track Table: As described in Section 3.3.2.

Track Plot: As described in Section 3.2.2.

Group Windows: As described in Section 3.2.2.

Analyze:

Analyze Track: As described in Section 3.2.2.

Debug:

Inspect Window: As described in Section 3.2.2.

3.5 CHANGE VIEW WINDOW

This window is shown in Figure 5.

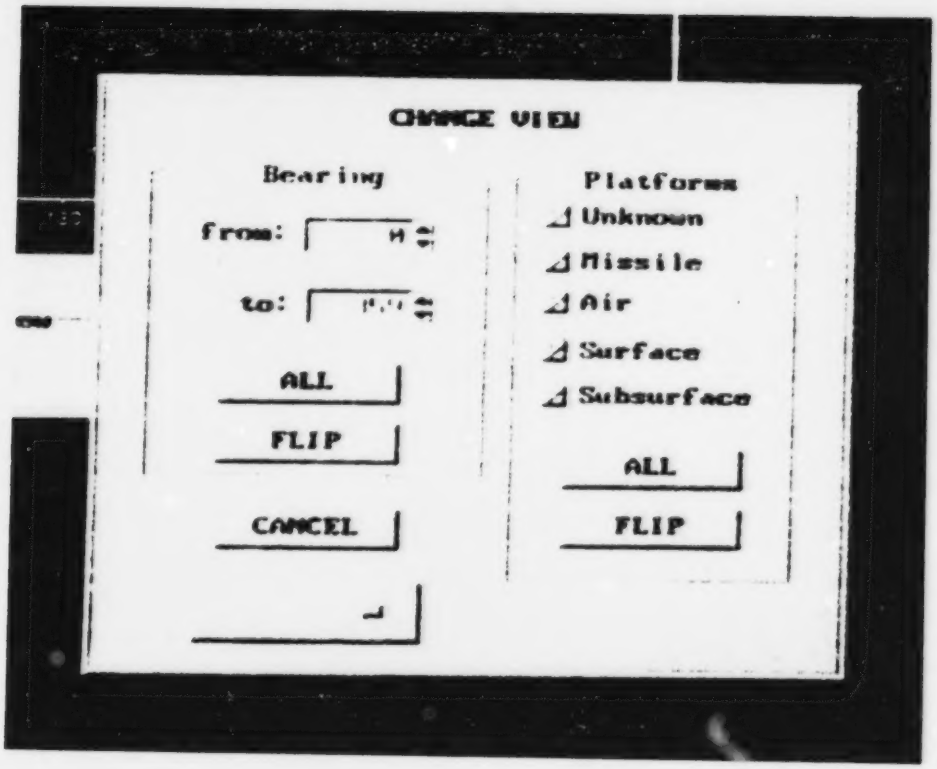

Figure 5 The Change View Window

This window allows modification to the view in which the operator is interested for the tabular and situation displays.

With respect to the Bearing area, the operator can view all emitters in 360 degrees around him or he can view a subsector. A subsector view would be useful for detailed examination or for disregarding a sector that is not of interest, for example, one that is known to contain only own force.

There is a "from:" space and a "to:" space in which to type the bearing sector bounds. There is an ALL button in the bearing area which, when clicked on, forces the bearing bounds back to "from: 0" "to: 360". There is a FLIP button which, when clicked on, forces the sector to be the complement of the current sector.

With respect to the Platform area there is a list of platforms types in which the operator could be interested. These include: Unknown, Missile, Air, Surface, and Subsurface. The operator can concentrate his attention on a subset of platform types by selecting only those of immediate interest, for example air and missile.

There is a check mark in the button beside the platform type if that platform type is to be included. By clicking in the box beside the platform type the check mark is toggled on or off. There is an ALL button in the Platforms area which, when clicked on, places a check mark in all the platform type boxes. There is a FLIP button in the Platforms area which, when clicked on, puts a check mark in the boxes without check marks and removes the check mark in boxes with check marks. In other words, the complement set is selected.

In addition, there is a CANCEL button which closes the Change View window without executing the changes made by the operator, and an ACCEPT button which closes the Change View window and executes the indicated changes.

3.6 TRACK ANALYSIS WINDOW

This window is shown in Figure 6.

This window will ultimately contain the information processed in CANEWS II for that emitter (or track). In future, when the track report is available, it will be displayed as the default.

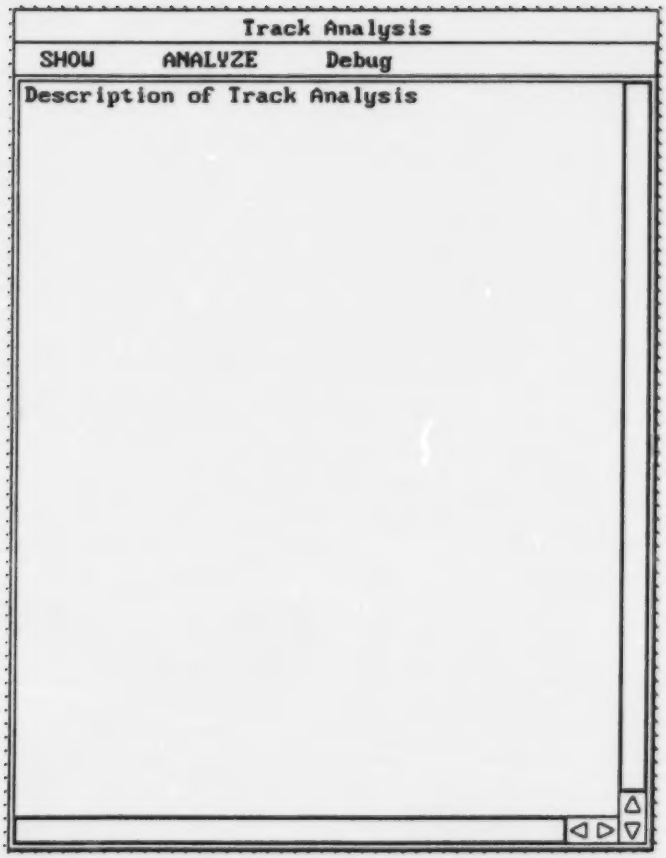

Figure 6 The Track Analysis Window

3.6.1 MENUS

Show:

Track Report: In future this will give the CANEWS II track report information which contains: the list of candidates and their confidence factors, the track's bearing (mean, range and rate of change), the pulse width (mean and range), the radio frequency (mean, range, and type), the PRI (mean, range, and type), the scan (means, ranges, type and period), the flags (FMOP, PMOP, CW), and the state (whether the emitter track is still accepting pulses or if it is just monitoring, and whether the emitter signal is still active).

Identification: In future this will give details on the candidates on the list including how well the emitter parameter data matched the emitter library descriptions, and in which mode the primary candidate matches the data.

RF Analysis, PRI Analysis, PW Analysis and Scan Analysis: In future these will give the classification deductions. [3]

Analyze: The operator can interact with and study the emitter data using the following windows and their data graphs.

Browse Pulses: This opens a Pulse Stream Browser window (described in Section 3.7).

PRI Histogram: This opens a PRI Histogram window (described in Section 3.8).

Falling Raster: This opens a Falling Raster window (described in Section 3.9).

Debug:

Inspect Window: Described in Section 3.2.2.

3.7 PULSE STREAM BROWSER WINDOW

This window is shown in Figure 7.

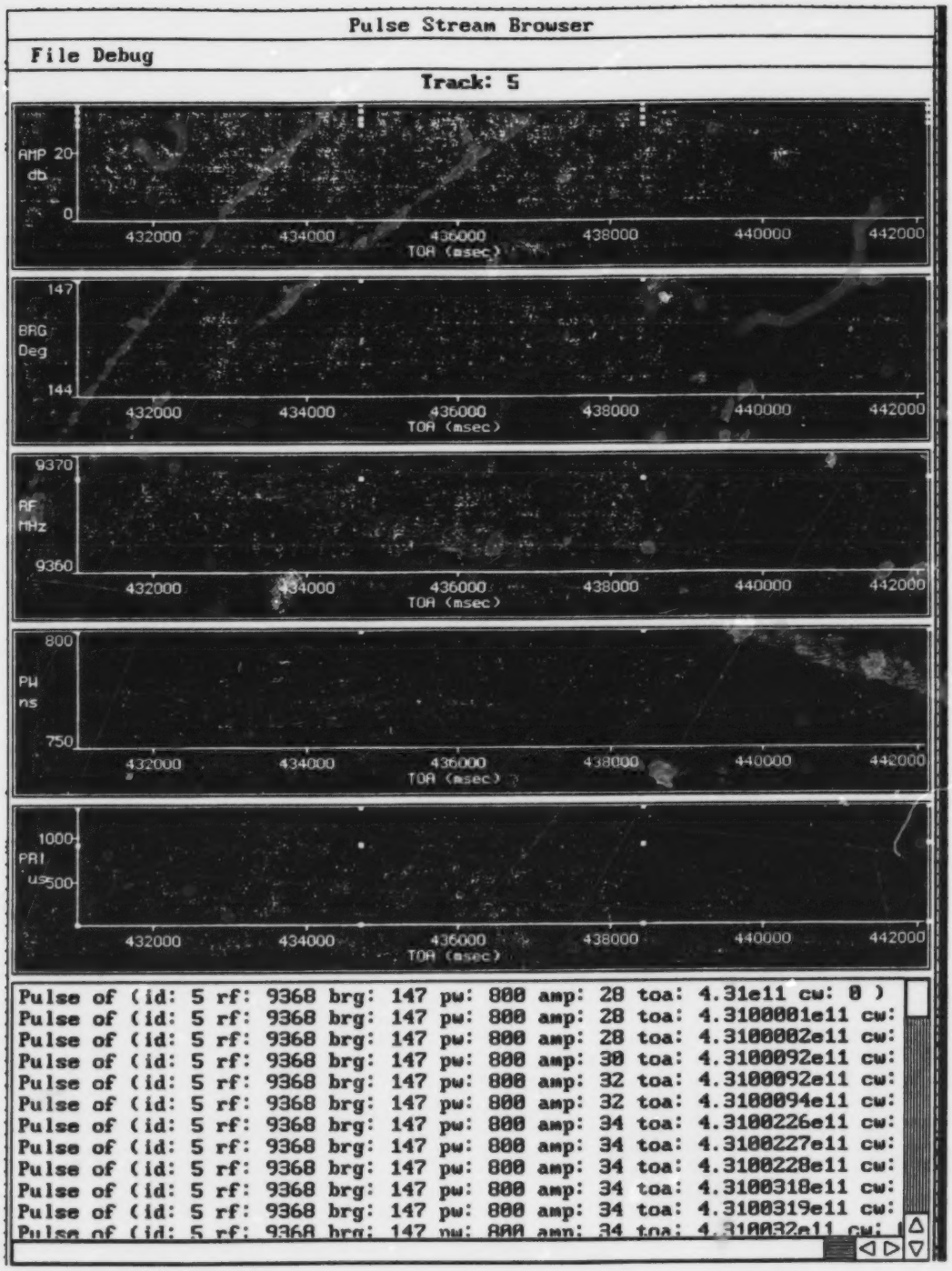
Pulse Stream Browser
File Debug
Track: 5
AMP 20
db
0
147
BRG
Deg
144
9370
RF
MHz
9360
800
PW
ns
750
1000
PRI
us
500
432000
434000
436000
438000
440000
442000
TOA (msec)
Pulse of (id: 5 rf: 9368 brg: 147 pw: 800 amp: 28 toa: 4.31e11 cw: 0)
Pulse of (id: 5 rf: 9368 brg: 147 pw: 800 amp: 28 toa: 4.3100001e11 cw:
Pulse of (id: 5 rf: 9368 brg: 147 pw: 800 amp: 28 toa: 4.3100002e11 cw:
Pulse of (id: 5 rf: 9368 brg: 147 pw: 800 amp: 30 toa: 4.3100092e11 cw:
Pulse of (id: 5 rf: 9368 brg: 147 pw: 800 amp: 32 toa: 4.3100092e11 cw:
Pulse of (id: 5 rf: 9368 brg: 147 pw: 800 amp: 32 toa: 4.3100094e11 cw:
Pulse of (id: 5 rf: 9368 brg: 147 pw: 800 amp: 34 toa: 4.3100226e11 cw:
Pulse of (id: 5 rf: 9368 brg: 147 pw: 800 amp: 34 toa: 4.3100227e11 cw:
Pulse of (id: 5 rf: 9368 brg: 147 pw: 800 amp: 34 toa: 4.3100228e11 cw:
Pulse of (id: 5 rf: 9368 brg: 147 pw: 800 amp: 34 toa: 4.3100318e11 cw:
Pulse of (id: 5 rf: 9368 brg: 147 pw: 800 amp: 34 toa: 4.3100319e11 cw:

Figure 7 The Pulse Stream Browser Window

The pulse data for the selected emitter is displayed in many formats in this window including:

i) The full table of all pulse parameters (listed in the bottom pane of the window).

ii) The graph of amplitude (in dB) plotted against time of arrival (in milliseconds).

iii) The graph of bearing (in degrees) plotted against time of arrival (in milliseconds).

iv) The graph of RF (in MHz) plotted against time of arrival (in milliseconds).

v) The graph of PW (in nanoseconds) plotted against time of arrival (in milliseconds).

vi) The graph of PRI (in microseconds) plotted against time of arrival (in milliseconds).

The graphs plotted against time show each pulse as a dot on the graph. In the future the operator will be able to click on pulses to highlight them, and the corresponding pulses in the four other time plots will also be highlighted. Also, in the future the operator will be able to zoom on a pulse selection and all five time plots will expand to include only the selected pulses. It will be possible to request a histogram on the pulse set within any of the panes. It is also intended to allow the operator to indicate an interval using cursor delimiters and have the interval time displayed. This will assist the operator in determining periods.

3.7.1 MENUS

File: Currently this menu is non-functional. This entire menu will be modified for the future operator interface. Its title will more likely be "Operations" and the menu items will include: "Unzoom" which will allow the operator to return to the original view of all the pulses instead of the selected subset; "Test as new emitter" which will allow the operator to have the system test if his selected subset of pulses can operate as a stand-alone separate emitter; and "Add new emitter" which extracts the pulses that have passed the test as a new emitter and creates a new track with the appropriate parameter limits. "Add new emitter" is an instance where the operator's ideas can be entered into the system, affect the processing and mould the tracking process. There will likely be tests before the "Add new emitter" is finalized that confirm the "Test as new emitter" has been done and the system agreed with the operator's hypothesis. The pulses that are

put into a new emitter would be extracted from the original track and that track's parameter limits adjusted accordingly.

Get a File: This is a artifact from the engineering display and is not applicable to the operator interface since the emitter (or file) has already been determined by the time this window is open. This menu item will be removed in the next operator interface iteration.

Next Partition, and Previous Partition: This is an artifact from the engineering display. Since data files were very large, the file could be partitioned and the partitions accessed separately. If sample sizes grow very large, partitioning may also be required in CANEWS II runs. It will be done differently than for the engineering display since data will have to be partitioned as data is being captured.

Debug:

Inspect Window: As described in Section 3.2.2.

3.8 PRI HISTOGRAM WINDOW

This window is shown in Figure 8.

The PRI histogram of the pulse data for the selected emitter is displayed in this window. The histogram is in a standard format with the PRI bin values along the x axis and the counts along the y axis. By using the PRI histogram the operator may determine the PRI type, for example constant or staggered, or if there are bins at multiples of the true PRIs due to dropped pulses.

In the future the operator will be able to zoom in on a selection of pulses in order to analyze pulse information in more detail. As in the Pulse Stream Browser window the operator will be able to test a subset of pulses from the PRI histogram as a new separate emitter and, if the pulses constitute a valid train, add this new emitter to the track list.

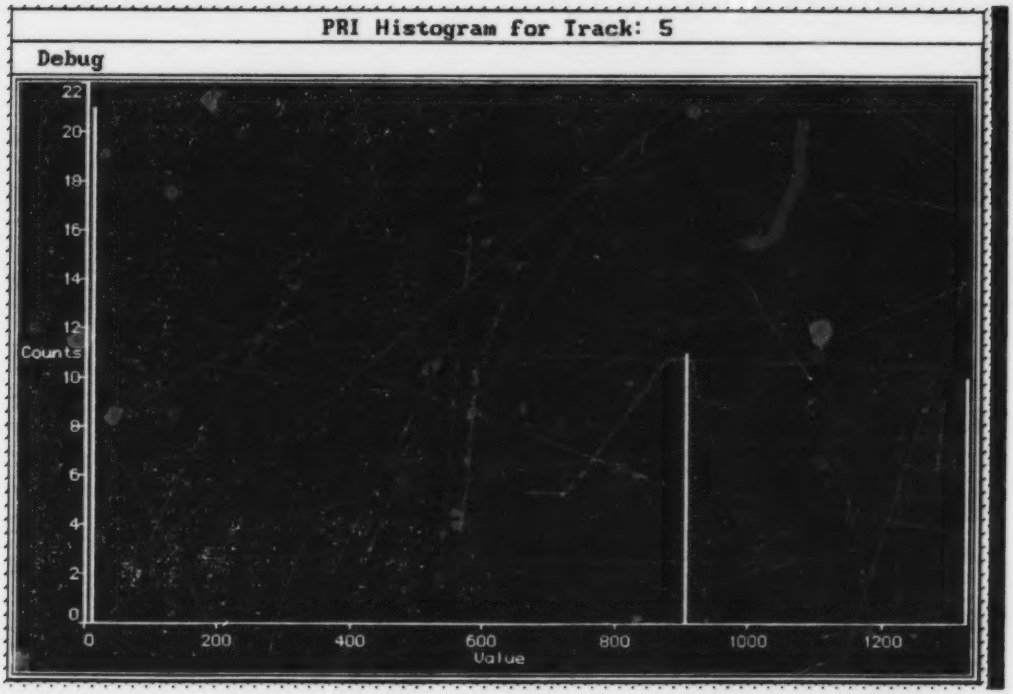

Figure 8 The PRI Histogram Window

3.8.1 MENUS

Debug:

Inspect Window: As described in Section 3.2.2.

3.9 FALLING RASTER WINDOW

This window is shown in Figure 9.

This window shows the graph of time versus time for each pulse in the track. Periodicity and patterns can be detected using this graph. For example, the period of the scan or PRI, depending on resolution, can be determined by lining up the pulses in a vertical line. For example, if the pulses can be lined up to form two distinct vertical lines, a sector scan pattern or a 2-level stagger can be assumed, once again depending on resolution. If the period resolution is small, in the order of 100 to 10000 microseconds, then likely only a single scan is on the graph at a time, individual pulses can be seen easily, and PRI behaviour can be viewed. If the period resolution is large, in the order of minutes, then the individual pulses would be difficult to detect and pulses within a scan would be lumped together. In this case scan behaviour can be viewed.

As well as the graph there is the Start (time of the first pulse seen on the graph), Period (time interval between pulses or groups of pulses), and Scan Height (vertical spread indicator). Each of Start, Period, and Scan Height can be adjusted by a sliding scale which increases to the right (see Appendix A for method).

In the graph the operator can highlight a pulse by clicking on it or boxing it. This pulse will then become the first pulse in the time series graph. The operator can modify the period by, after highlighting a pulse with the left-most button, highlight a pulse in the same manner with the right-most button on the mouse. The graph uses the time between these two selected pulses as the period and re-aligns the graph as required.

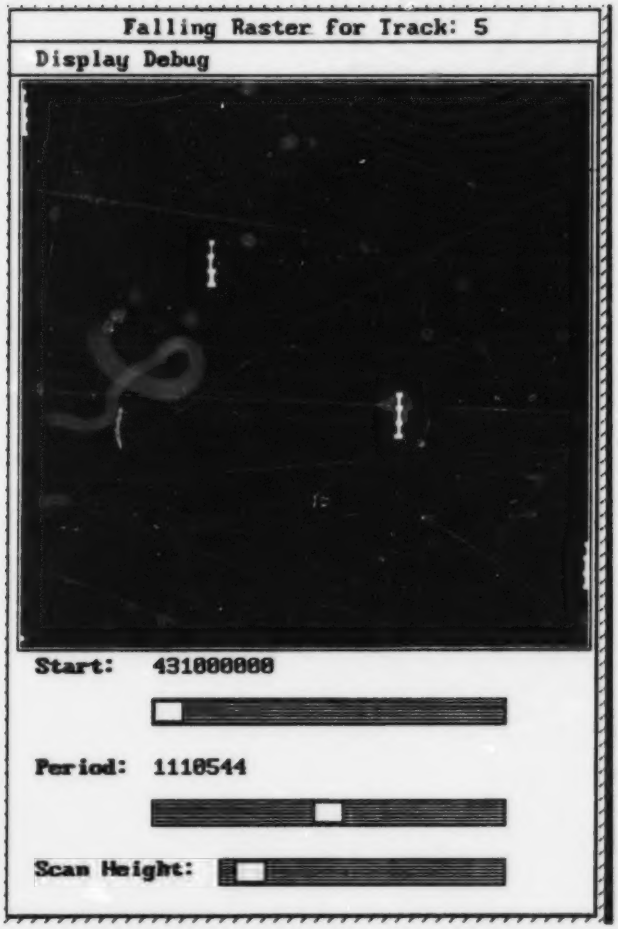

Figure 9 The Falling Raster Window

3.9.1 MENUS

Display:

Re-initialize: This returns the falling raster graph to its original set of pulses with its original start time.

1D: This displays the pulses with no amplitude dimension. With the period resolution in the order of minutes each scan will appear as a point.

2D: This displays the pulses with an amplitude value in the y axis dimension. With the resolution in the order of minutes each scan will appear as a line of points above one another.

Debug:

Inspect Window: As described in Section 3.2.2.

3.10 ACTIVE PLATFORMS TABULAR WINDOW

This window is shown in Figure 10.

The attributes of the known platforms are listed in tabular form in this window. Currently this description includes the platform name and which tracks (or emitters) in the environment are known to be on the platform. In future this description will be more extensive. For example, the description will include bearing and range estimate.

A platform can be selected by clicking on the platform information line of choice.

3.10.1 BUTTONS

Sort by: By clicking on the button to the right of "Sort by" the list of possible sort parameter is shown, including: Platform ID, Bearing, Range Estimate. Currently "Sort by" is not operational but in future the sort function will be available.

Describe Selection: If a platform has been selected then this button opens the detailed platform description window (described in Section 3.12).

View: As described in 3.2.1.

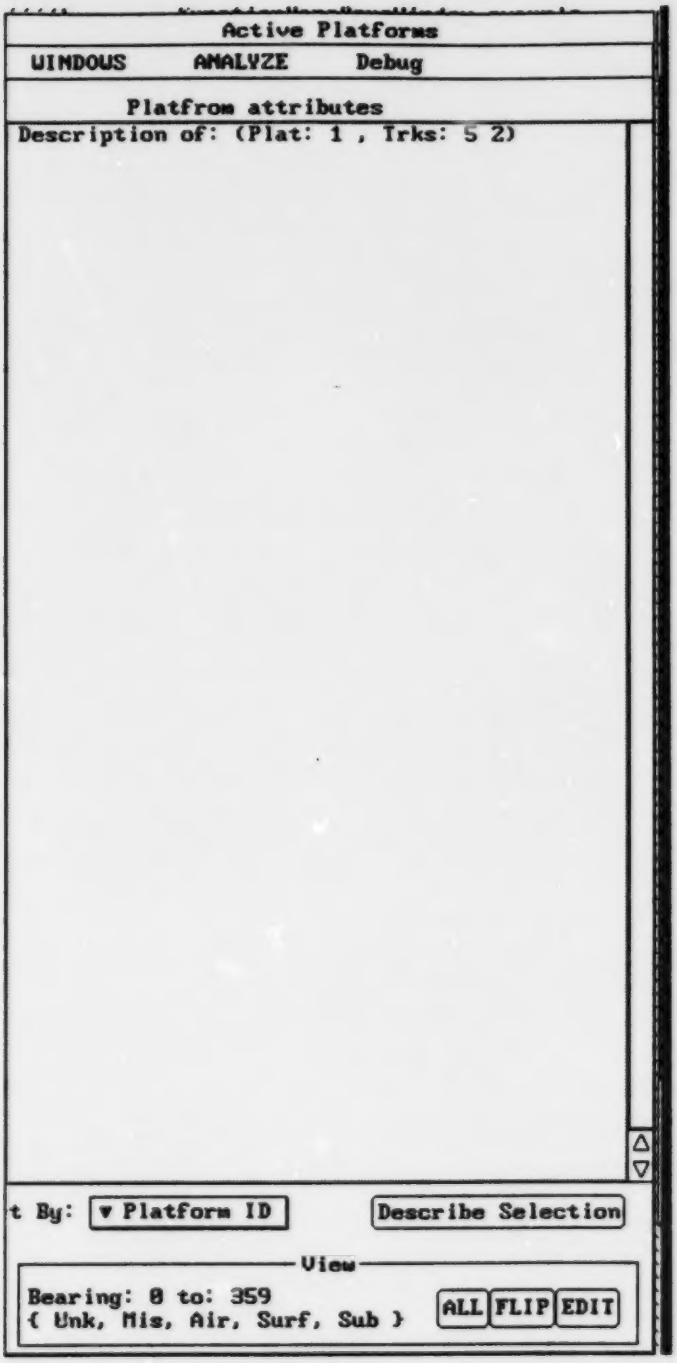

Figure 10 The Active Platforms Tabular Window

3.10.2 MENUS

Windows: As described in Section 3.2.2 with Platform Plot behaving in the manner of Track Plot.

Analyze:

Analyze Platform: Opens a Platform Analysis window (described in Section 3.13).

Debug:

Inspect Window: As described in Section 3.2.2.

3.11 ACTIVE PLATFORM SITUATION DISPLAY WINDOW

Examples of this window are shown in Figures 11a and 11b.

The received data on the platforms are displayed in an amplitude versus bearing graphical plot. The default is the polar version. Currently the amplitude value is the amplitude of the strongest emitter on the platform, however, in future, a more useful parameter to use would be the range to the platform, calculated from the power of the emitters.

The choice of situation plots includes:

a) AMP vs BRG (Polar):
This format is shown in Figure 11a. It is a polar display with amplitude (0 to 60 dB, 60 dB at the origin) along the axes, and bearing (0 to 360 degrees) around the polar circle.

b) AMP vs BRG (XY):
This format is shown in Figure 11 b. It is a cartesian display with amplitude (0 to 60 dB) along the y axis, and bearing (0 to 360 degrees) along the x axis.

A platform can be selected by clicking on or boxing its icon.

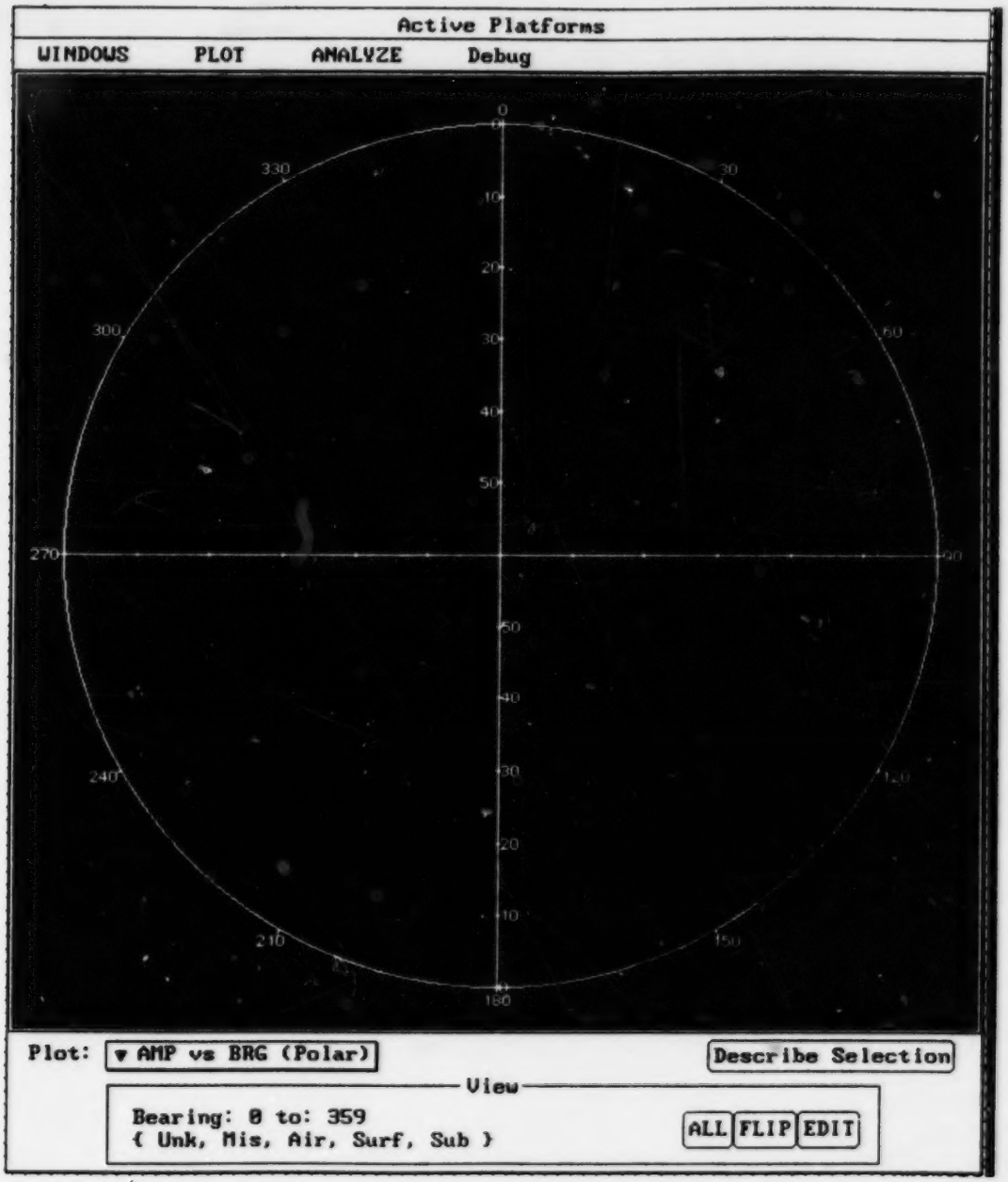

Figure 11a The Active Platform Situation Window (AMP vs BRG (Polar))

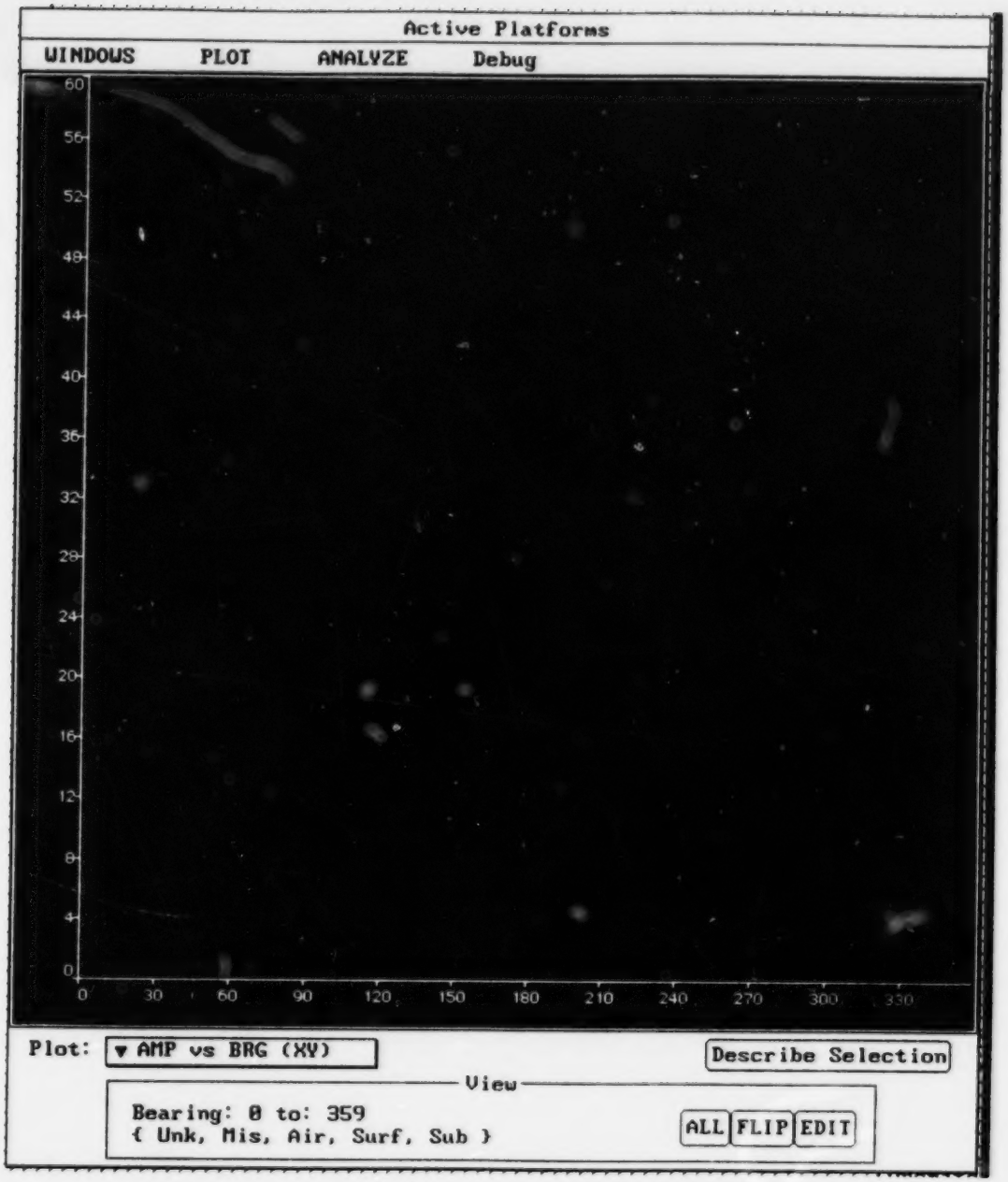

Figure 11b The Active Platform Situation Window (AMP vs BRG (XY))

3.11.1 BUTTONS

Plot: By clicking the button to the right of "Plot" a list of possible plot formats appears, including: AMP vs BRG (Polar), and AMP vs BRG (XY). After choosing one of the button menu items the graphical plot will be drawn accordingly.

Describe Selection: As described in Section 3.10.1.

View: As described in 3.2.1.

3.11.2 MENUS

Windows: As described in Section 3.3.2 with Platform Table behaving as Track Table is described.

Plot:

Toggle Grid: As described in Section 3.3.2.

Zoom: As described in Section 3.3.2.

Analyze:

Analyze Platform: As described in Section 3.10.2.

Debug:

Inspect Window: As described in Section 3.2.2.

3.12 PLATFORM DESCRIPTION WINDOW

This window is shown in Figure 12.

The expanded data information on the selected platform is displayed in this window. Currently the information includes the platform name and the emitters identified as being on that platform. In future there will be more extensive information retrieved from the platform database.

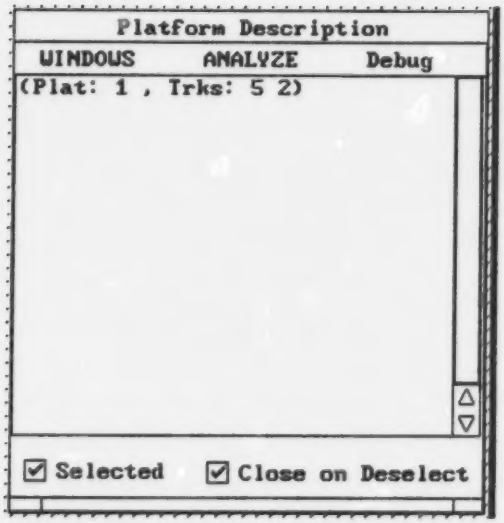

Figure 12 The Platform Description Window

3.12.1 BUTTONS

Selected: If this button contains a check mark then the contents of the window apply to the currently selected platform. If the button is clicked on, the platform becomes unselected in the active platform tabular and situation windows, and the platform description window closes if the "Close on Deselect" is check marked.

Close on Deselect: If this button contains a check mark then the window will remain open only while the current emitter is selected. If this button does not contain a check mark then this window will remain open until the operator specifically closes the window. Having more than one detailed description window open at a time allows the operator to compare various platforms.

3.12.2 MENUS

Windows:

Platform Table: Same as described in Section 3.3.2 with Platform Table behaving as Track Table.

Platform Plot: Same as described in Section 3.2.2 with Platform Plot behaving as Track Plot.

Group Windows: As described in Section 3.2.2.

Analyze:

Analyze Platform: As described in Section 3.10.2.

Debug:

Inspect Window: As described in Section 3.2.2.

3.13 PLATFORM ANALYSIS WINDOW

This window is shown in Figure 13.

The window will ultimately contain the information processed in CANEWS II for the selected platform with the platform report shown by default.

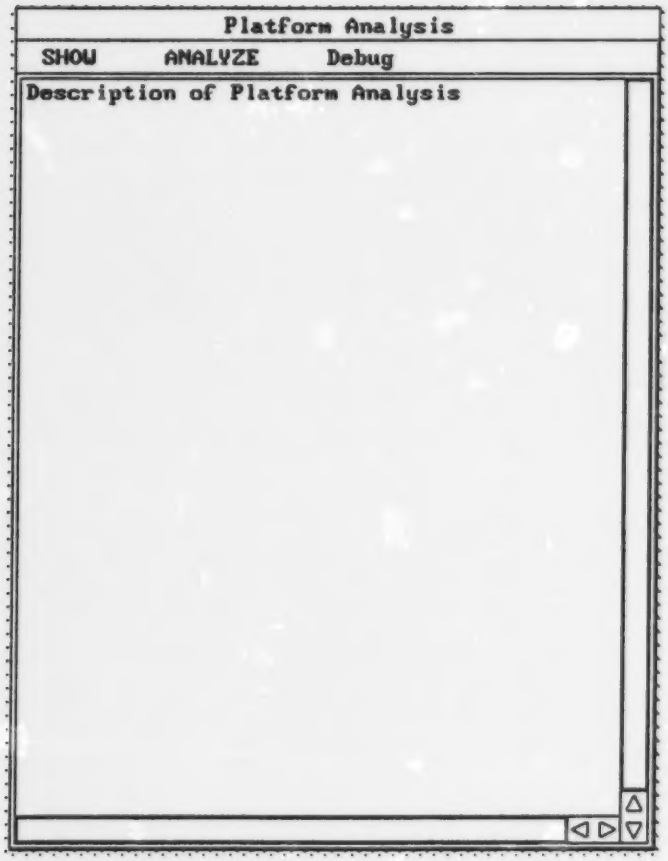

Figure 13 The Platform Analysis Window

3.13.1 MENUS

Show:

Platform Report: In future this will give information similar to the track report. This could include what emitters are active on the platform and the list of other candidate platforms with their respective rankings. [3]

Explain Inference: In future this will give the information leading to the conclusions about the platform. [3]

Analyze:

Browse Blackboard: In future this will allow the operator to review the relationships between various platform hypotheses, in a graphical format. [3]

Debug:

Inspect Window: As described in Section 3.2.2.

3.14 OVERALL LAYOUT

The subsections of Section 3 described the individual windows. The operator will be able to have as many windows open for analysis as he wants. The advantages of viewing many windows concurrently include the ability to compare data or review data in many formats. The flexibility of window choice and numbers allows the operator to tailor the display for any requirement. However, with this flexibility comes the possibility of too much complexity and confusion. Windows can overlap partially, or a window can completely obscure another. Of course, critical information cannot be obscured. The operator will need to be trained to close windows no longer needed, thereby using as clear an interface as possible.

Figure 14 shows a display with a number of windows open including three track situation display formats. This could be used by an operator to obtain a complete feel for the environment around own ship. One situation display could be a cartesian frequency/bearing display; another could be a polar situation display with amplitude indicated; another could be polar with frequency. Each of these formats would assist the operator in a different way.

Figure 15 shows a display with the track tabular and situation displays along with five track description windows. This could be used by an operator to compare a number of emitters in detail.

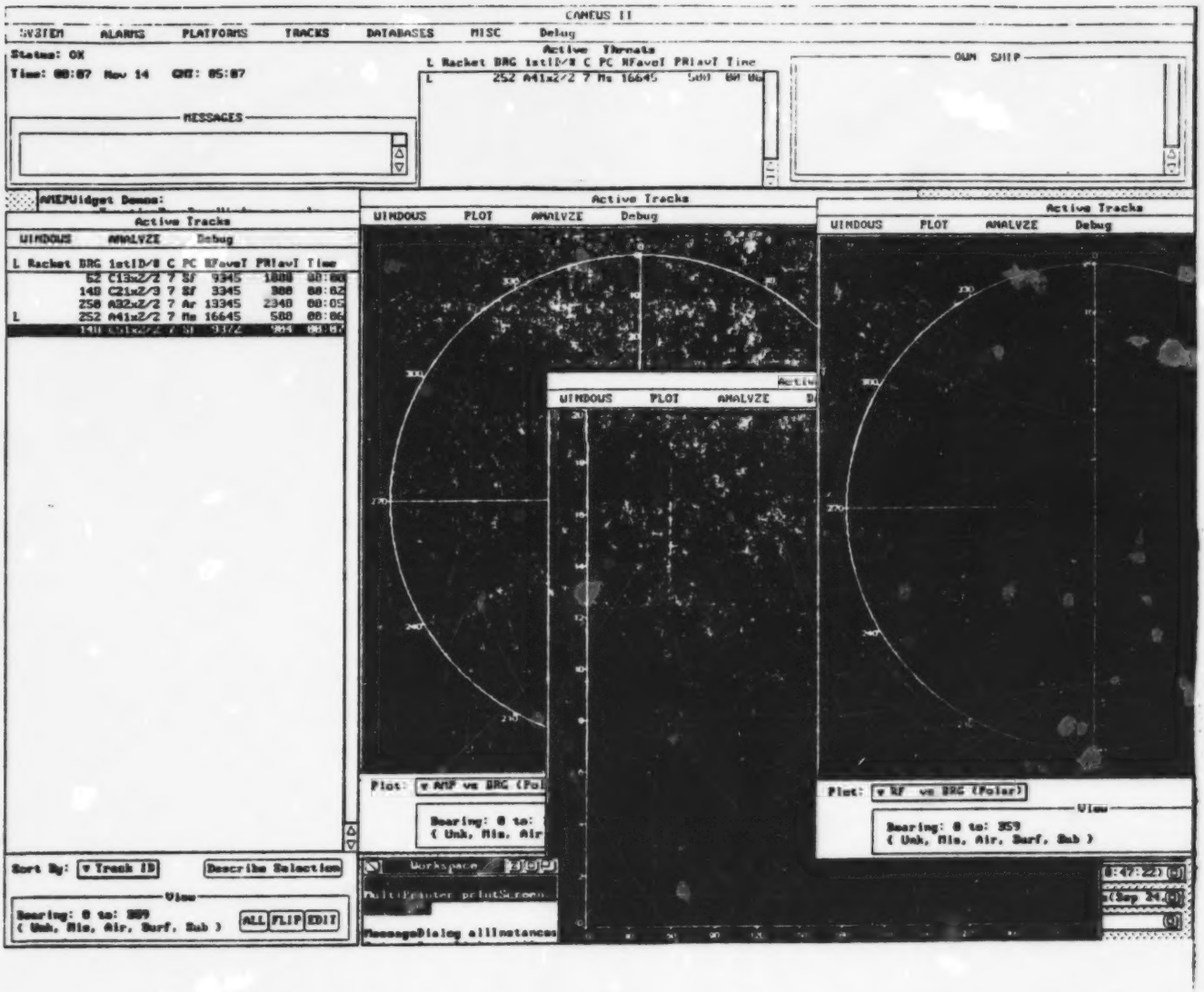

Figure 14 A Full Screen Including Three Track Situation Windows

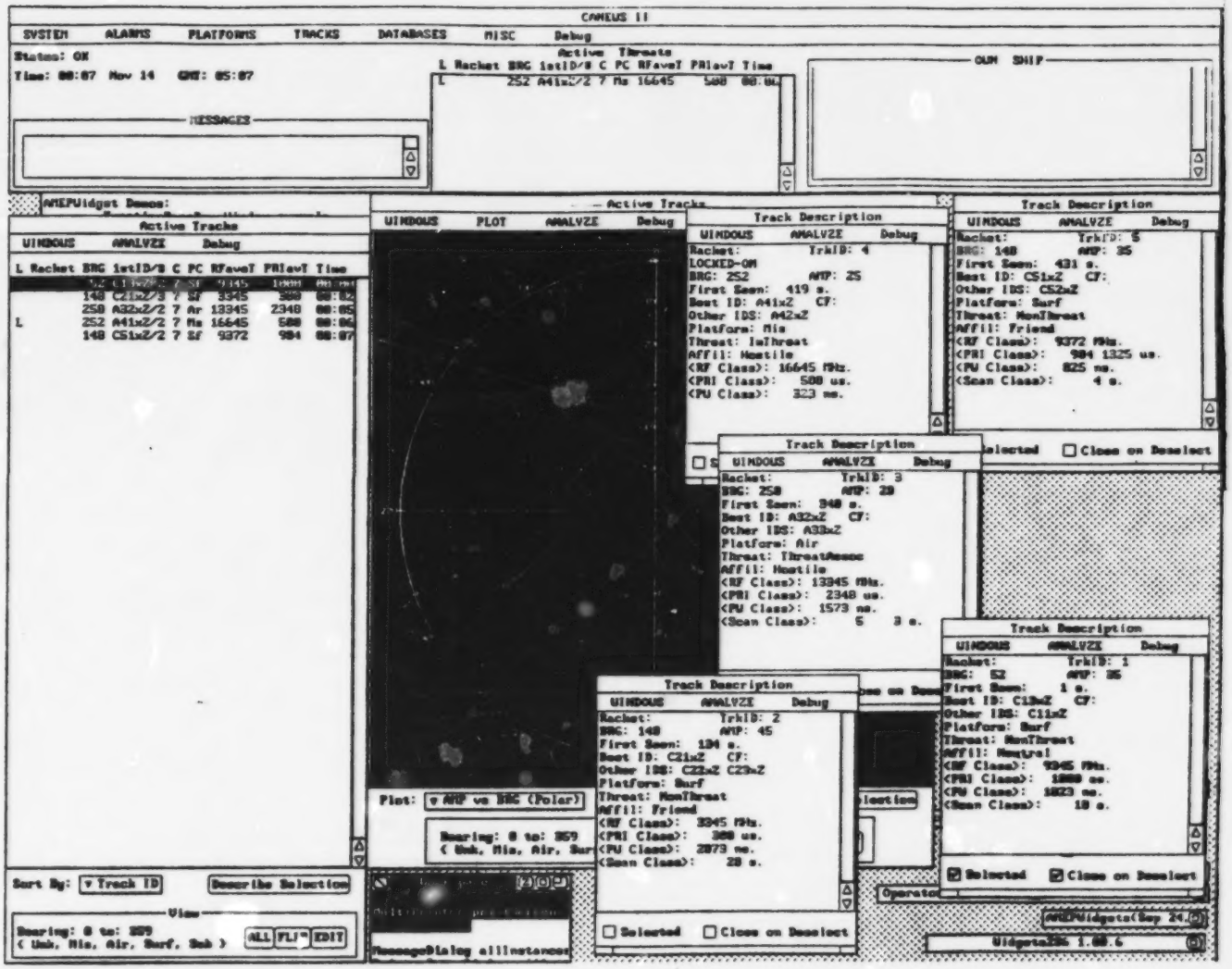

Figure 15 A Full Screen Including Five Track Description Windows

Figure 16 shows the three windows that involve detailed pulse analysis. It is quite likely that the operator would use all three windows simultaneously to get a thorough understanding of how the pulses for an emitter behave.

The data in all windows will be updated as new information is received. In the case of the pulse analysis windows constant updates could be distracting to the operator. For the Falling Raster graph, new data would simply be added to the end of the data to be graphed and, therefore, would not add confusion. For the PRI Histogram, the sizes of the bins would grow with new data. Typically this would not introduce much confusion since the operator would usually be reviewing the relative positions of the bins. However, in order to avoid a change of scale in the middle of analysis, in future the operator may be able to control when updates get introduced by accessing an "update" menu item. For the Pulse Stream Browser graph, updates would confuse the operator considerably since the scale of the x axis would have to continually expand with succeeding data. With this in mind, in future the operator will request updates to his pulse analysis graph by accessing an "update" menu item.

Too many open windows could clutter the display and might cause confusion. A conscientious operator would close windows no longer in use. There are some cases where windows are automatically closed without the direct intervention of the operator. For example, in the case of Track Description windows, when the track is no longer current the corresponding Track Description window is closed, unless forced to remain open by the operator. This is also the case for Platform Description windows. This philosophy of subordinate windows closing automatically when parent or higher-level windows are closed may be applied for a number of cases in future if it appears cluttered screens will not be adequately controlled by the operators. Automatic closures can be easily applied for the pulse analysis windows. All of the pulse analysis windows (Pulse Stream Browser, PRI Histogram, and Falling Raster) relate to a single track, so if that track is deselected all of the associated pulse analysis windows would close. As in the case of the Track Description window, the operator can force the windows to remain open.

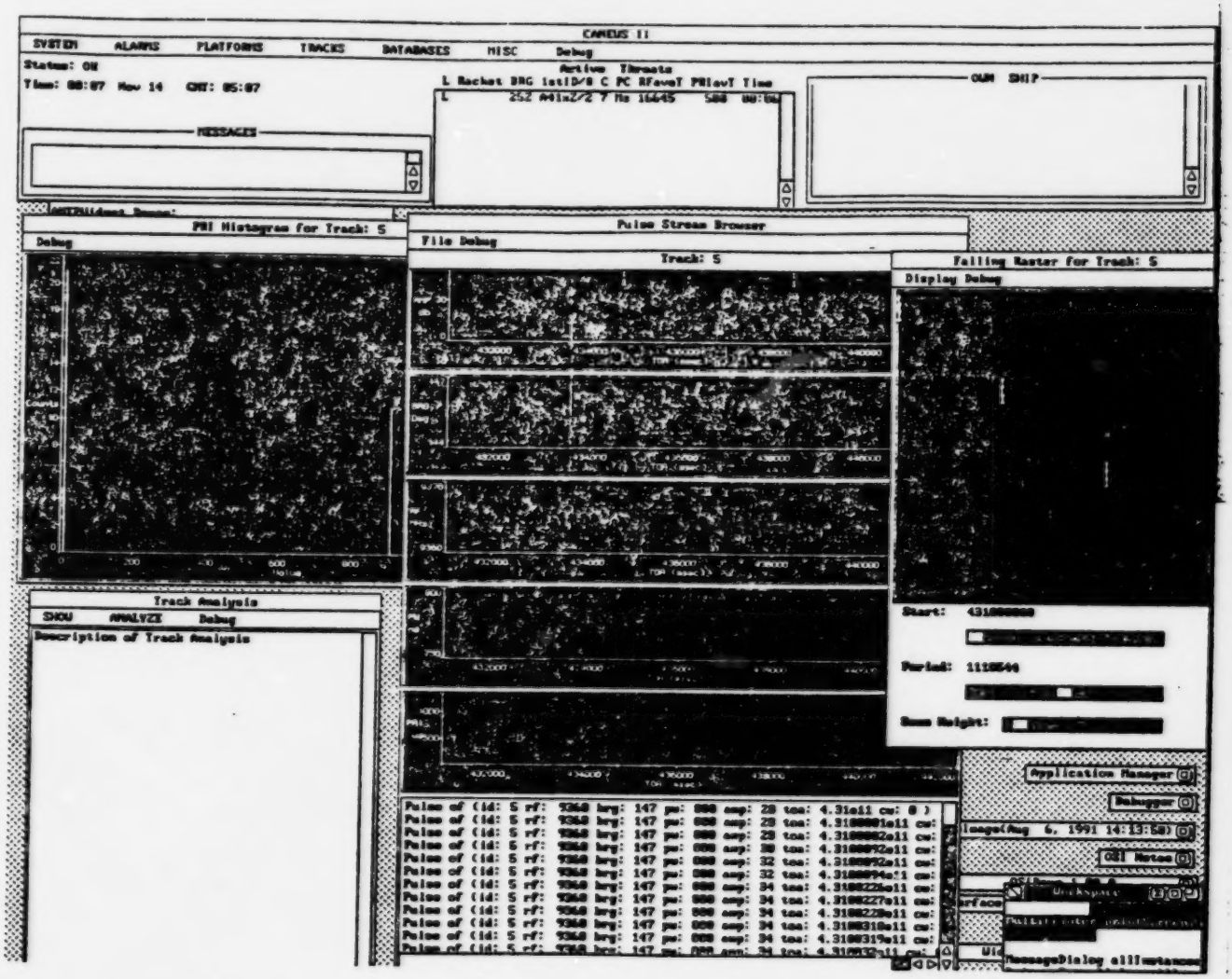

Figure 16 A Full Screen Including All Track Analysis Windows

4.0 FUTURE PLANS

Throughout the descriptions of the individual windows in the above sections there were many indications of future plans and changes. In addition to the changes planned for specific windows there are some general plans and improvements. These will be described in this section.

The original operator interface mock-up did not receive CANEWS II data directly. The next operator interface iteration will be tied to CANEWS II and will have the capability of receiving processed pulses through CANEWS II.

Some thought will be given to using auditory cues to alert the operator to certain information. Care must be taken with auditory cues since they can be annoying in some instances and lost in background in other instances. In addition to auditory cues there are plans to allow the operator to listen to the pulse train using ear phones. Along with the ability to listen to the pulse train is the requirement for a stop watch so the operator can time the scan periods.

Techniques for the operator to input his deductions about pulse trains were discussed in Sections 3.7.1 and 3.8. Further thought will be given to other deduction input techniques, through which windows the operator will enter his deductions, and how the system will check the validity of those deductions.

In future a two-dimensional pulse plot would be useful for pulse level analysis. For example, a graph of the frequencies versus the PRIs of the pulses would be helpful for the operator to review the CANEWS II filtering.

Hardcopy outputs of the pulse analysis windows may be useful in the future for doing detailed off-line studying of pulse trains.

The current use of colour for emitters and platforms includes red for threat, orange for hostile, green for neutral, and cyan for friendly. The old CANEWS used red for threat , pink for hostile, white for unknown, and cyan for friendly [2]. In spite of the requirement to decide if pink or orange is optimum for hostile, these colours and their usage are familiar and effective. Some tests will be done to decide which background colours would be most effective. Currently greys, whites, and blacks are used for background colours. While this is very neutral there is some feeling that the use of green, as in radar screens, would be preferable. Whichever colour is chosen for backgrounds, consideration must be given to legibility of data and text on that background colour.

Currently when the operator accesses a window in the operator

interface, he must first click the left-most mouse button with the cursor somewhere within the window in order to make the window active. This is easy enough to get used to, but can slow the operator down. In the next iteration of the operator interface the window containing the cursor will automatically become the active window.

The next iteration of the operator window will use consistent terminology. For example, the term emitter will be used throughout instead of also using track since the operators are more familiar with the term emitter. A consistent choice will be made among the terms plot, situation display and PPI.

5.0 CONCLUSIONS

This paper introduces the CANEWS II operator interface and describes the preliminary design. This preliminary design permits the interface to be studied, its positive aspects enumerated and its weak points considered for improvement.

The content, layout and operation of the interface is discussed. The content and use of each window in the operator interface is described in detail along with future plans for each window. General plans for improvements to the operator interface are also presented.

The preliminary design of the CANEWS II operator interface has been received favourably by ESM scientists and operators. The interface has been found to be flexible and useful. In spite of the display being information intensive, learning how to use the interface is straightforward as most of the operations are associated either with buttons or menu selections. The planned improvements should further enhance the utility of the interface, reduce confusion, and make the presentation of the considerable information even more straightforward and useful.

This paper introduces the CANEWS II operator interface, and it is hoped that thoughts, suggestions and discussion will come from the ESM community and the final operator interface will be optimal.

6.0 REFERENCES

1. Barbara Ford, "The Optimization of Display Formats for the CANEWS ESM System (U)" CONFIDENTIAL, DREO Technical Note 84-11, August 1984.

2. PO1 T. Kelly (Canadian Forces Fleet School Halifax), Private Communication, September 1991.

3. John Altoft (Alteck Systems Inc.), Private Communication, 1991.

ACKNOWLEDGEMENTS

John Altoft (Alteck Systems Inc.) wrote the Smalltalk code for the preliminary design operator interface and offered many useful suggestions concerning the display content. PO1 T. Kelly, from Canadian Forces Fleet School Halifax, contributed useful feedback from the ESM operator point of view concerning the preliminary design. Barry Williams (Lockheed Canada) contributed his code modifications which made ENVY/Developer and Widgets/V286 compatible.

APPENDIX A

METHODS FOR SPECIFIC MOUSE OPERATIONS

Click on an item:

Press the left-most button down while the cursor is on top of the item.

Box an item:

Press the left-most button down at the start position and, while holding the button down, move the cursor to its final position. The start position will be one corner of the rectangle which will surround the item of interest and the final position will be the opposite corner.

Close a window:

Click on the "square centred within a square" button in the upper left corner of the window.

Re-size a window:

Click on the "square in the upper left corner of a square" button on the right side of the label bar. While holding down the left-most button drag the cursor to the new lower right extent of the window.

Move a window:

Click anywhere on the window title bar and hold down the mouse button while the window is dragged to its new location.

Scroll data (or move data up or down) within a pane:

Click on the up arrow (the triangle pointing up), in the lower right corner of suitable panes, as many times as needed to move the data up the required amount.

Click on the down arrow (the triangle pointing down) as many times as needed to move the data down the required amount.

Shift data (or move data left or right) within a pane:

Click on the right arrow (the triangle pointing right), in the lower right corner of suitable panes, as many times as needed to move the data to the right the required amount.

Click on the left arrow (the triangle pointing left) as many times as needed to move the data to the left the required amount.

Access a menu item:

Press the left-most button down while the cursor is on top of the menu title of choice. While holding the button down, move the cursor on top of the menu item of choice then release the button.

Adjust sliding scale:

While the cursor is on top of the slide button, press the left-most button down. While holding down the button move the slide button left or right to the new desired position and release the button.

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(U) CANEWS II receives emitted radar pulses, groups related pulses, classifies pulse parameters and matches the classifications against an emitter library in order to make identifications. The operator interface presents pulse, emitter and platform information to the operator, and allows the operator to view and manipulate the data in a variety of ways. In this paper, the preliminary design for the CANEWS II operator interface is described in detail, along with plans for subsequent modifications.

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